

The documentation and process conversion measures necessary to comply with this revision shall be completed by 28 August 2015.

INCH-POUND

MIL-PRF-19500/99F
29 May 2015
SUPERSEDING
MIL-S-19500/99E
31 July 1967

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, NPN, SILICON, SWITCHING, MEDIUM-POWER,
THROUGH-HOLE MOUNT, TYPES 2N696 AND 2N697,
QUALITY LEVEL JAN

Inactive for new design after 7 June 1999.

This specification is approved for use by all Departments
and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of
this specification sheet and [MIL-PRF-19500](#).

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon, switching, medium power transistors. One level of product assurance (JAN) is provided for all encapsulated devices.

1.2 Package outlines. The device package outlines are as follows: TO-205AA (formerly modified TO-5) (without suffix S, see [1.5.3](#)) or a TO-205AD (formerly modified TO-39) (with suffix S, see [1.5.3](#)) in accordance with [figure 1](#) for all encapsulated device types.

1.3 Maximum ratings. Unless otherwise specified, $T_A = +25^\circ\text{C}$.

P_T		V_{CBO}	V_{EBO}	V_{CER} $R_{BE} = 10\ \Omega$	θ_{J-C}	T_J and T_{STG}
$T_A = +25^\circ\text{C}$ (1)	$T_C = +25^\circ\text{C}$ (2)					
\underline{W} 0.6	\underline{W} 2	$\underline{V_{dc}}$ 60	$\underline{V_{dc}}$ 5	$\underline{V_{dc}}$ 40	$\frac{^\circ\text{C}}{\text{mW}}$ 0.075	$\frac{^\circ\text{C}}{\text{C}}$ -65 to +200

(1) Derate linearly 4 mW/ $^\circ\text{C}$ for $T_A > +25^\circ\text{C}$.

(2) Derate linearly 13.3 mW/ $^\circ\text{C}$ for $T_C > +25^\circ\text{C}$.

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

AMSC N/A

FSC 5961



1.4 Primary electrical characteristics. Unless otherwise specified, $T_A = +25^\circ\text{C}$.

Limits	h_{FE2} (1) $V_{CE} = 10\text{ V dc}$ $I_C = 150\text{ mA dc}$		$ h_{FE} $ $V_{CE} = 10\text{ V dc}$ $I_C = 50\text{ mA dc}$ $f = 20\text{ MHz}$		Switching		C_{obo} $V_{CE} = 10\text{ V dc}$ $I_E = 0$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$	$V_{CE(sat)}$ (1) $I_C = 150\text{ mA dc}$ $I_B = 15\text{ mA dc}$	$V_{BE(sat)}$ (1) $I_C = 150\text{ mA dc}$ $I_B = 15\text{ mA dc}$
					t_{on}	t_{off}			
	2N696	2N697	2N696	2N697	nsec	nsec	pf	V dc	V dc
Min	20	40	2.5	3.0			2	0.3	---
Max	60	120	10	12	200	1,000	25	1.5	1.3

(1) Pulsed (see 4.5.1).

1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.4 for PIN construction example and 6.5 for a list of available PINs.

1.5.1 JAN certification mark and quality level. The only quality level designator for encapsulated devices that is applicable for this specification sheet is the base quality level "JAN" that uses no modifiers.

1.5.2 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

1.5.2.1 First number and first letter symbols. The transistors of this specification sheet use the first number and letter symbols "2N".

1.5.2.2 Second number symbols. The second number symbols for the transistors covered by this specification sheet are as follows: "696" and "697".

1.5.3 Suffix symbols. The suffix symbol "S" is used on devices that have a shortened lead length: 0.5 inch (12.7 mm) minimum to .75 inch (19.1 mm) maximum. Devices with standard length leads (see figure 1) use no suffix.

1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on QPDSIS-19500.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-19500 – Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 – Test Methods for Semiconductor Devices.

(Copies of these documents are available online at <http://quicksearch.dla.mil>.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in [MIL-PRF-19500](#) and as specified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see [4.2](#) and [6.3](#)).

3.3 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein shall be as specified in [MIL-PRF-19500](#) and as follows:

$$t_{off} - - - - - t_s + t_f$$

3.4 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in [MIL-PRF-19500](#) and herein. The device package style is a TO-205AA (formerly modified TO-5) or a TO-205AD (formerly modified TO-39) in accordance with [figure 1](#) for all device types.

3.4.1 Lead finish. Unless otherwise specified, lead finish shall be solderable in accordance with [MIL-STD-750](#), [MIL-PRF-19500](#), and herein. Unless otherwise specified (see [6.2](#)), the lead finish shall be gold-plate. Where a choice of lead finish or formation is desired, it shall be specified in the acquisition document (see [6.2](#)).

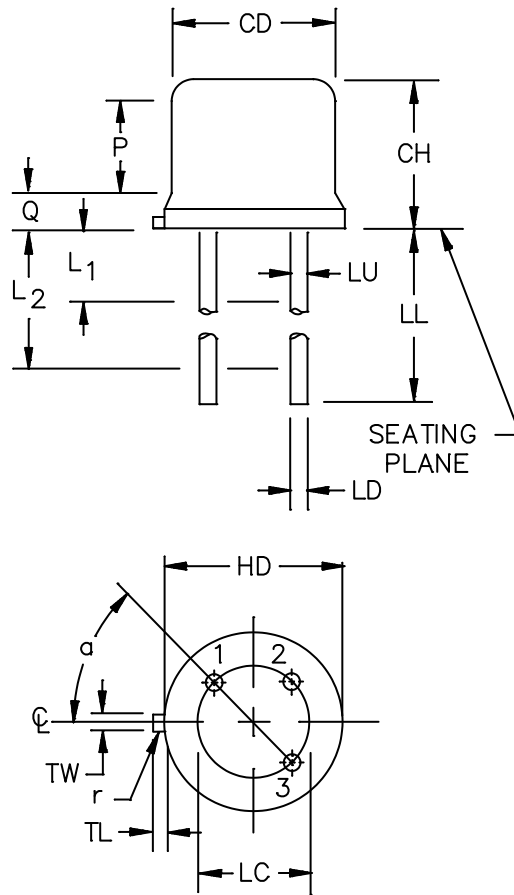
3.4.2 Pin-out. The pin-out of the device shall be as shown on [figure 1](#). Terminal 1 is the emitter, terminal 2 is the base, and terminal 3 is the collector. The collector shall be electrically connected to the case.

3.4.3 Terminal-lead length. Terminal-lead length(s) other than that specified on [figure 1](#) may be furnished under contract or order (see [6.2](#)) where the devices covered herein are required directly for particular equipment-circuit installation or for automatic-assembly-technique programs. Where other lead lengths are required and provided, it shall not be construed as adversely affecting the Qualified-product status of the device, or applicable JAN marking (see [6.2](#)).

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics shall be as specified in [1.3](#), [1.4](#), and [table I](#) herein.

3.6 Marking. Marking shall be in accordance with [MIL-PRF-19500](#).

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	3
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		4
LD	.016	.021	0.41	0.53	5, 6
LL	See notes 6, 7, and 8				
LU	.016	.019	0.41	0.48	5, 6
L ₁		.050		1.27	5, 6
L ₂	.250		6.35		5, 6
P	.100		2.54		3
Q		.030		0.76	9
TL	.029	.045	0.74	1.14	10, 11
TW	.028	.034	0.71	0.86	10
r		.010		0.25	12
α	45° TP		45° TP		4



NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Lead 1 = emitter, lead 2 = base, lead 3 = collector. The collector shall be internally connected to the case.
3. CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
4. Leads at gauge plane $.054 + .001 - .000$ inch ($1.37 + 0.03 - 0.00$ mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods or by gauging procedure.
5. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in and beyond LL minimum.
6. All three leads.
7. For the modified TO-5 package (PINs without the S suffix), LL is 1.500 inch (38.10 mm) minimum and 1.750 inch (44.45 mm) maximum.
8. For the modified TO-39 package (PINs with the S suffix), LL is .500 inch (12.70 mm) minimum and .750 inch (19.05 mm) maximum.
9. Body contour optional within zone defined by CD, HD, and Q.
10. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 (0.28 mm).
11. Dimension TL measured from maximum HD.
12. Dimension r (radius) applies to both inside corners of tab.
13. In accordance with ASME Y14.5M, diameters are equivalent to Φ x symbology.

FIGURE 1. Physical dimensions and configuration of TO-205AA and TO-205AD packages.

3.7 Workmanship. Devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4 and [tables I and II](#)).

4.2 Qualification inspection. Qualification inspection shall be in accordance with [MIL-PRF-19500](#), and as specified herein.

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of [table II](#) tests, the tests specified in [table II](#) herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.3 Screening. Screening is not applicable for devices compliant to this specification sheet.

4.4 Conformance inspection. Conformance inspection shall be in accordance with [MIL-PRF-19500](#), and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with [MIL-PRF-19500](#) and [table I](#) herein. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table E-VIB of [MIL-PRF-19500](#) and herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B1	2026	Omit preconditioning.
B3	1027	$T_A = 25^\circ\text{C}$; $P_T = 600 \text{ mW}$; $V_{CE} = 30 \text{ V dc}$.
B5	3131	

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of [MIL-PRF-19500](#) and as follows herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C2	2036	Test condition E.
C6	1026	$T_A = 25^\circ\text{C}$; $P_T = 600 \text{ mW}$; $V_{CE} = 30 \text{ V dc}$

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of [MIL-PRF-19500](#) and as specified in [table II](#) herein.

4.5 Method of inspection. Methods of inspection shall be as specified in herein and as follows.

4.5.1 Pulse response measurements. The conditions for pulse response measurement shall be as specified in section 4 of [MIL-STD-750](#).

4.5.2 Transient thermal impedance. The transient thermal impedance measurements shall be performed in accordance with test method 3131 of [MIL-STD-750](#) using the guidelines in that test method for determining I_M , I_H , t_H , t_{sw} , (and V_H where appropriate). See [table II](#), subgroup 4 herein.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance 2/	3131	See 4.5.2	$Z_{\theta JX}$		0.075	$^{\circ}\text{C/W}$
Collector to base, cutoff current	3036	Bias condition D; $V_{CB} = 60 \text{ V dc}$,	I_{CBO1}		10	$\mu\text{A dc}$
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 7 \text{ V dc}$,	I_{EBO1}		10	$\mu\text{A dc}$
Collector to emitter breakdown voltage	3011	Bias condition B, $I_C = 100 \text{ mA dc}$, $R_{BE} = 10 \text{ ohms}$; pulsed (see 4.5.1)	$V_{(BR)CER}$	40		V dc
Collector to base, cutoff current	3036	Bias condition D; $V_{CB} = 30 \text{ V dc}$,	I_{CBO2}		0.1	$\mu\text{A dc}$
Forward-current transfer ratio 2N696 2N697	3076	$V_{CE} = 10 \text{ V dc}$, $I_C = 10 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE1}	20 40	--- ---	
Forward-current transfer ratio 2N696 2N697	3076	$V_{CE} = 10 \text{ V dc}$, $I_C = 150 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE2}	20 40	60 120	
Forward-current transfer ratio 2N696 2N697	3076	$V_{CE} = 10 \text{ V dc}$, $I_C = 500 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE3}	12.5 20.0	--- ---	
Collector to emitter voltage (saturated)	3071	$I_C = 150 \text{ mA dc}$, $I_B = 15 \text{ mA dc}$; pulsed (see 4.5.1).	$V_{CE(sat)}$	0.3	1.5	V dc

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2 - continued</u>						
Base to emitter voltage (saturated)	3066	Test condition A; I _C = 150 mA dc, I _B = 15 mA dc; pulsed (see 4.5.1).	V _{BE(sat)}		1.3	V dc
<u>Subgroup 3</u>						
High temperature operation		T _A = +150°C				
Collector to base cut-off current	3036	Bias condition D, V _{CB} = 30 V dc, pulsed (see 4.5.1)	I _{CBO3}		10	μA dc
Low temperature operation		T _A = -55°C				
Forward-current transfer ratio 2N696 2N697	3076	V _{CE} = 10 V dc, I _C = 200 mA dc;	h _{FE}	10 20		
<u>Subgroup 4</u>						
Magnitude of common emitter small-signal, short-circuit forward-current transfer ratio 2N696 2N697	3306	V _{CE} = 10 V dc, I _C = 50 mA dc; f = 20 MHz	h _{FE}	2.5 3.0	10 12	
Open circuit output capacitance	3236	V _{CB} = 10 V dc, I _E = 0; 100 kHz ≤ f ≤ 1 MHz	C _{obo}	2	25	pf
Switching time						
Turn-on time		See figure 3	t _{on}		200	nsec
Turn-off time		See figure 4	t _{off}		1000	nsec
<u>Subgroups 5 and 6</u>						
Not applicable						

1/ For sampling plan, see MIL-PRF-19500.

2/ This test required for the following end-point measurements only:

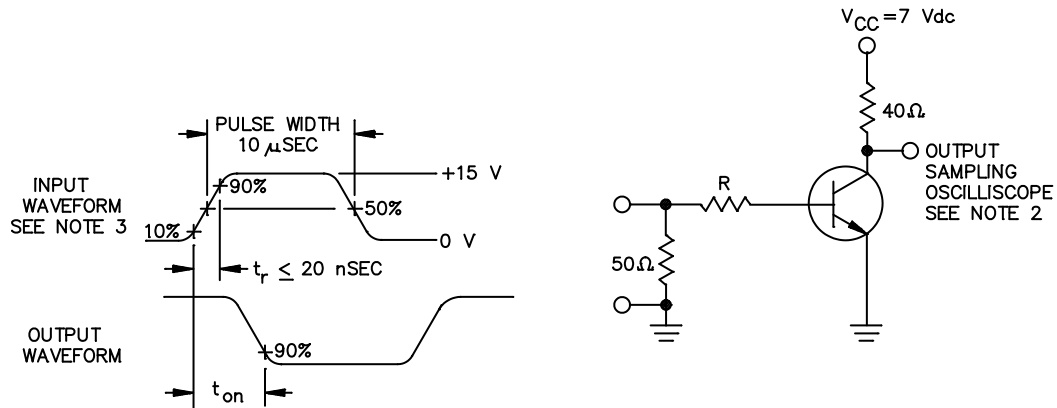
Group B, subgroups 2 and 3.

Group C, subgroups 2 and 6.

Group E, subgroup 1.

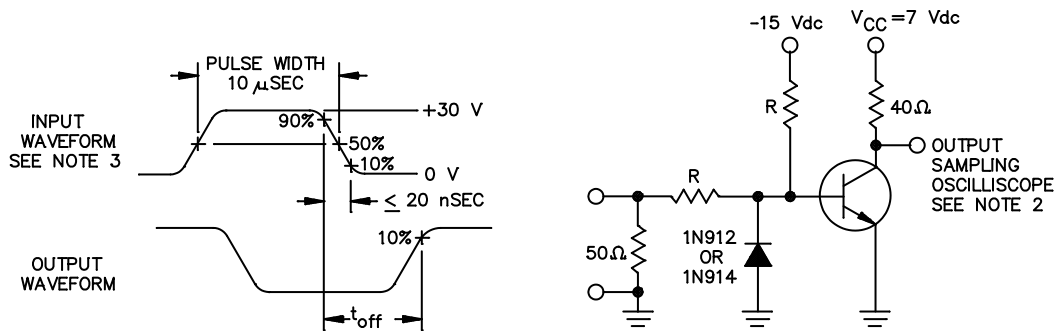
TABLE II. Group E inspection (all quality levels) – for qualification and requalification only.

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles.	
Hermetic seal Fine leak Gross leak	1071		
End-point electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent operating life	1037	6,000 cycles, $T_A = 25^\circ\text{C}$, $P_T =$ sufficient to achieve ΔT_J of 100°C , $V_{CE} = 40\text{ V dc}$, adjust device current, or power, to achieve a minimum ΔT_J of 100°C .	
End-point electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500 .	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	



NOTES:

1. Equivalent circuits may be used.
2. Sampling oscilloscope: $Z_{in} \geq 100$ K ohms, $C_{in} \leq 12$ pf, $t_r \leq 15$ nsec.
3. Duty cycle = 1 percent.

FIGURE 3. Switching time ($t_d + t_r$) test circuit.

NOTES:

1. Equivalent circuits may be used.
2. Sampling oscilloscope: $Z_{in} \geq 100$ K ohms, $C_{in} \leq 12$ pf, $t_r \leq 15$ nsec.
3. Duty cycle = 1 percent.

FIGURE 4. Switching time ($t_s + t_f$) test circuit.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in [MIL-PRF-19500](#) are applicable to this specification.)

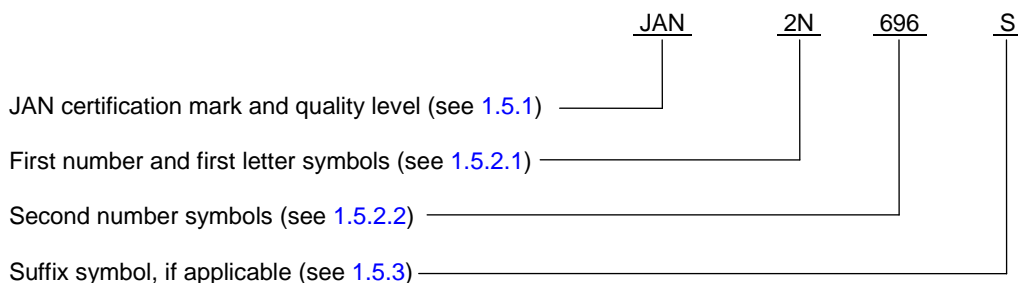
6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see [3.4.1](#)).
- d. The complete PIN, see [1.5](#), 6.4 and [6.5](#).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil.

6.4 PIN construction example. The PINs for encapsulated devices are constructed using the following form.



6.5 List of PINs. The following is a list of possible PINs available on this specification sheet.

PINs for devices in a modified TO-5 package (standard lead lengths)	PINs for devices in a modified TO-39 package (short lead lengths)
JAN2N696	JAN2N696S
JAN2N697	JAN2N697S

6.6 Supersession information and superseded PINs.

6.6.1 Lead finish. The original issue of this specification through MIL-S-19500/99D (3 December 1964) did not specify a lead finish. MIL-S-19500/99E (1 May 1967) specified that the lead finish as "gold-plated". That same revision also allowed for "tin coated" as an option for lead finish. Tin is no longer acceptable as a lead finish.

6.6.2 Lead length. The original issue of this specification through MIL-S-19500/99E with amendment 1 (25 September 1966) did not contain a suffix to designate lead length. MIL-S-19500/99E with amendment 2 (15 July 1986) introduced the "S" suffix option with the associated TO-205AD package. When applicable, PINs covering devices with a shortened lead length now shall include a suffix "S" to designate this package configuration (see 1.2, 1.5, and figure 1).

6.7 Request for new types and configurations. Requests for new device types or configurations for inclusions in this specification sheet should be submitted to: DLA Land and Maritime, ATTN: VAC, Post Office Box 3990, Columbus, OH 43218-3990 or by electronic mail at "Semiconductor@dla.mil" or by facsimile (614) 693-1642 or DSN 850-6939.

6.8 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians:
 Army – CR
 Navy – EC
 Air Force – 85
 DLA – CC

Preparing activity:
 DLA – CC
 (Project 5961-2015-038)

Review activities:
 Army – AR, MI
 Navy – AS, CG, MC, SH
 Air Force – 19, 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil>.